

## QEP Faculty Champion Reporting Template: Spring Semester 2015

Faculty Champion: Dr. Yelena White, School of Math and Science

### Directions:

Summarize the critical thinking activities that you engaged in by responding to the following questions. Include important details and attach relevant documents if desired.

#### How did you teach critical thinking in your courses?

##### ➤ Critical thinking goals:

My goals are to teach students to think through problems in different ways and find approaches that allow efficient and effective problem solving. Students should be able to exhibit reflective thinking in a systematic way. Students learn to arrange and systemize their knowledge in a way that promotes higher level thinking, understanding of the material, long-term retention, forming connections between theory and daily applications, and going “above and beyond” the stated problem. Students learn to provide data and evidence in support of their arguments, draw evidence-based conclusions, and yet be open to the arguments presented by their peers.

In my Physics II and Integrated Science courses, I have concentrated on the following outcomes:

X	2	Students will demonstrate the ability to (a) gather, (b) analyze, and (c) evaluate information to make effective decisions.
X	3	Students will demonstrate the ability to solve problems (a) algebraically, (b) numerically, and (c) graphically at the level necessary to succeed in higher education.
X	4	Students will demonstrate effective use of the scientific method.

With that said, students benefited from other learning outcomes (mainly, #5 and 7) due to the nature of these courses and the amount of reading that is involved.

##### ➤ Teaching strategies:

Since I taught science courses in the Spring of 2015, I based my critical thinking teaching strategies on the steps of Scientific Method:

- Observation;
- Hypothesis;
- Experiment/ data collection;
- Data analysis;
- Conclusions/ new hypothesis.

When we start a new topic or chapter, I briefly outline what we are going to work on during that lesson, and then I gather information on how much students already know about the topic. Since I have been trying a “flipped classroom” approach, students are expected to come to class prepared for discussion. However, we still need to “sort” the information that they have gathered and arrange it in a way that promotes understanding and long-term retention. Usually, after we discuss the theory, we go into

applications and work on “word” problems or case studies that show how a particular concept can be applied. I use the Socratic Method in my teaching- I lead the discussion with questions that promote higher level thinking and information gathering. I believe that asking the right questions puts students have way through to the answers. Most of the times I find that students already have enough knowledge and background information to answer questions but this knowledge is not systematically arranged, preventing students from drawing conclusions.

$$F_{grav} = G \frac{m_1 m_2}{R^2}$$

Example: Newton’s Law of Gravity,

Question: do you think your weight on Jupiter will be greater or smaller than on Earth? Quantify your results.

The students make a hypothesis based on general knowledge that the weight should be higher because Jupiter is “bigger” than Earth. But what does “bigger” mean? Is it heavier or larger? Again, based on what they already know, it’s both. They collect the data on the size for both planets and draw conclusions that the weight on Jupiter should be about 11 times greater. But when they account for masses of the planets, they see that according to the calculations, the weight on Jupiter is only about three times greater than on Earth. So “bigger” actually doesn’t mean “better.” This promotes further discussion on inverse square laws, density, and other concepts.

To summarize the example above, students went from common observations to forming questions, to answering these questions through research and supportive information, to forming deeper questions and drawing high-level conclusions. This is the structure that I promote in every class. The typical questions that I might ask during any class period are listed below:

- What do you know about (topic)?
- When was it first discovered and who made the discovery?
- Why is it relevant today?
- How is it relevant to you, in particular?
- Which approach would you choose to solve this problem?
- Where do you start?
- Why do you think this approach is better than (xyz)?
- Do you think your strategy always works or are there any exceptions that you need to list?
- Look at the solution proposed by your peer. What do you think? Is it better? Why?

Often times, I make students explain a problem to their neighbor or (if this makes them more comfortable) pretend to explain it to their younger siblings. I believe that when they state a problem out loud and have to list every single step, they understand the problem better and find new, efficient ways to solve it.

➤ **Rubrics/other assessment methods:**

- My student evaluation and grading is based on assessments that are given throughout the course. In each of my courses, students are offered four formative assessments (chapter tests) throughout the semester to evaluate their performance and comprehension of the

material. These formative assessments are a part of my students' final grade (usually ~45-60%). They also serve as a benchmark and allow myself, as well as my students, to make predictions about student performance on the end-of-semester summative assessment (final exam, ~20% of the grade).

- In my Physics I and Physics II classes, students receive criterion-referenced assessments throughout the semester (~10 quizzes, counting for 10% of the total grade). These assessments are very short and should not take more than five minutes. In my flipped physics classrooms, I rely on these quizzes to assess my students' comprehension of the material, their dedication, and the direction that a given class period should take: can we move on with the topic? Should we slow down and discuss some concepts in more details? In other words, these quick criterion-referenced assessments give me a clear idea about my students' "*muddiest points*." As of right now, I have not flipped my Physical Science and Integrated Science courses; therefore, the quizzes are not offered in those classes. Instead, I use suggested homework problems as my reference for the "*muddiest points*."
- In addition to four formative and a summative assessments, the students in my Physics I and II, Integrated Science, and Physical Science courses are evaluated on their hands-on lab assignments (~10-20% of the grade). Students have to answer pre-lab questions (20% of the lab grade) to show that they are prepared for the lab assignment. Each lab emphasizes the concepts that have been covered during the week of the lab. Labs enhance material comprehension and retention, provide connections between "seeing" and "doing", and offer students to develop their laboratory skills, critical thinking skills, see real time application of scientific method, and develop lab safety techniques. These are some of the primary outcomes of science courses.
- Another primary outcome of science course is development of scientific vocabulary. This is also achieved through laboratory assignments, as students are expected to present their experiments and conclusions at the end of each lab. As a summative assessment that addresses this particular outcome, we use end-of-semester science project, where students have to give 15 minutes presentations on various scientific topics. Students also submit a two-page summary of their research, written in accordance with MLS

guidelines, which dramatically improves their writing skills. I stopped offering the end-of-semester projects in my physics classes as I found out that our college lacks several important (and expensive) pieces of lab equipment that are necessary for these projects. Even if students try their very best, their work is not comprehensive enough due to the lack of experimental apparatus. Instead, this outcome is achieved through class discussions and weekly laboratory assignments.

- The main reason that my Physical Science students take the course is because it is required for their major. Currently, all students in my Physical Science course are in Elementary Education program, although many of them become middle school teachers after completing their degree at Georgia Southern University. Instead of the end-of-semester science project, these students have to complete a demo lesson at one of the local elementary or primary schools. This is a great opportunity that allows them to try themselves as teachers. It addressed every primary objective of a physical science course, it takes a lot of planning and preparation, and it allows students to see what it's like inside a real classroom. Before they go in to teach a class (approved by a local K-5 teacher), we discuss the details of their project and I help them with any questions about teaching, experiment, or explanation. After the demo-class is taught, students have to submit their evaluations, formal lesson plan, and self-reflections. A number of times our former students shared that this particular project helped them excel at GSU or UGA teaching programs, as it made going to class less stressful and more familiar.
- When I look for strategies to improve my teaching and students' understanding of the material, I employ "productive persistence" techniques, developed by the Carnegie Foundation for the Advancement of Teaching (<http://www.carnegiefoundation.org/>). The strategy is based on Plan-Do-Study-Act, or PDSA, cycle, which gives a quick criterion reference and allows instructors to adjust their teaching during semester, or even during a given class session. This is another example of my criterion-referenced assessment, although some parts of it are not graded.

Example:

- **Plan:** my benchmark is that students are familiar with the units of measurements- at least for 85% of the variables.
- **Do:** run a short units quiz, asking questions, such as, “what are the units of velocity, acceleration, and momentum?”
- **Study:** collect the results and compare data to the goals outlined in the “Plan”. The results are far from exciting (less than 50%). I study the results and try to restructure teaching technique, bringing more “real life” into conceptual situation. For example, when discussing velocity, I ask students (*\*as stated before, I try use the Socratic approach whenever possible- ask questions first before giving the answer, or guide students to the answers by asking questions*) to define it. Then I ask them to think about it in daily terms. Speed or velocity how much distance someone has to cover in a given time. In other words, it’s a rate at which you cover certain distance, isn’t it? So the units have to be of length and time, or length over time, to be exact. In SI units, this corresponds to m/s.
- **Act:** After I adapt this explanation, I give students another quick test and analyze the results. In most situations, I see improvement. But if not, I reassess my strategies and start over.

#### **What worked best for you in teaching critical thinking?**

The Socratic Approach to problem solving and to guide class discussion is something that worked very well. In the beginning, I felt like I was answering my own questions and mostly talking to myself but as semester moved on, students adjusted to the classroom that was centered on developing their critical thinking and problem solving skills. I also place a lot of importance on PDSA cycles described above. This is a quick and efficient way to check if students grasped a concept or if we need to spend more time on it.

#### **Did you encounter any unanticipated problems in teaching critical thinking?**

Often times I notice that students are not well-prepared for their formative assessments. This can be due to the fact that assessments are not always based on multiple-choice, and even if they are, students still have to perform calculations and employ their critical thinking and problem solving skills rather than rely on pure memorization. In recent years, it seems like learning trends from elementary through high school are based on memorization rather than understanding of

material. Therefore, when students are faced with new teaching and learning strategies and critical thinking requirements, they are not sure how to adjust and be successful in class.

➤ **How you responded to these problems:**

I spend a lot of time discussing study techniques and test preparation techniques with my students. In the Fall of 2014, I started giving out an informal quiz that helps them assess their own readiness and learning. It also helps students think of the strategies that can be used on the next test to make them more successful. Below is a sample list of questions.

Before-the-Test Survey

1. Do you feel prepared for the test?
2. What have you done so far to study for the test?
3. How (if at all) do you plan to study for the test in the remaining time?
4. What kind of grade are you hoping to earn?

After-the-Test Analysis

1. Did you put your absolute best effort into this test?
2. How many hours have you studied for this test?
3. Did you ask for help? (come to instructor's office hours, ACE center, classmates)
4. What was the most difficult for you on this test?
5. Do you think you can do better? What do you need to do to make improvements?
6. Will you follow your own suggestions in #5 to make improvements on the next test?

I gave these surveys in my Integrated Science course as a part of cognitive learning approach. This was given right after the disappointing results of our first semester test. The average on that test **66%** and the average on the next test was **71%**. While the 5% increase in the average might not seem sufficient, some of the individual student gains are as high as 33%. The material on the second test was more difficult than it was on the first test, and I attribute the improvement to my pre- and post-test surveys and learning strategies discussion.

Just as in the Fall of 2014, I have included the learning strategies in my syllabus. This is a quote from my Physics II syllabus from Spring, 20015:

**HELP!!! I am lost and don't know where to start!**

- First of all, do not panic!
- Second, try to identify the source of your confusion. Ask yourself some questions: Do you not understand the material? Why is that? What exactly do you not understand? If the answer is “None of it”, then chances are that you have not read the chapter. If not, go read it! And I mean, read it, don't just look at the text. Science books are not like history or literature text books, and they are not detective stories or novels. The material is cumulative, and you need to really understand one concept before moving on to the next one, but in the end, we most likely will not find why vector A killed vector B. Here are some reading suggestions:
  - Read at a slower pace. Take notes while reading. Write down all of the questions that you have. After you complete the chapter, look over your questions again. Can you answer them now? If not, bring them to class or to my office hours.
  - Carefully work through every example in the chapter. Work on your own first, and then compare the solutions given in the book. Start working on the chapter early in the week but don't try to nail it all at once. Take breaks!

These websites contain more detailed suggestions on how to read science textbooks:

- How to Read Effectively in the Sciences:  
<http://academic.cuesta.edu/acasupp/AS/621.htm>
- Reading Assignments in Science:  
<http://www.studygs.net/science/readingtexts.htm>

- Come to my office hours. Office hours are times that I set aside when I promise to be in my office to help you. During these times, feel free to ask questions about the course material, your current standing, best ways to prepare for tests, or homework questions. I will be in a better position to help you with material if you come prepared. Have your textbook, notes, and problems that you are working on with you.

Come if you have questions about something that is outside the scope of this course. Want to talk about lasers or careers in physics- come on by! If you have general questions about being a college student or have difficulties that need to be discussed, feel free to come and talk to me.

If the listed office hours do not work for you, email me with your questions or set up an appointment at a different time.

- Go to ACE center for help. lecture tutorials with you.
- Talk to your classmates and arrange study groups. Use student lounge, library or ACE to get together. Exchange emails and phones so you can contact each other quickly.

**How did the introduction of critical thinking affect student learning in your courses?****➤ Qualitative assessment results:**

I am going to refer to the example that I have described in the “Teaching Strategies” section. After the introduction of the Socratic Method and Scientific Method-based approaches and

following them in every class and lab period during the whole semester, I have noticed that students made a great progress in developing their critical thinking skills. They also were able to argue their points, participate in meaningful, structured discussion, improve their research skills, and deliver their arguments and conclusions in a professional manner. Instead of “Well, you know what I mean, right?” responses and shy smiles, my students were able to provide in-depth explanation and answer their peers’ questions.

➤ **Quantitative assessment results:**

**Pre- and Post-Test data**

<b>Math- Science Division</b>	<b>Dr. White</b>				<b>Spring, 2015</b>				
<b>Course</b>	<b>Course No.</b>	<b>CRN</b>	<b>Students</b>	<b>Items</b>	<b>Pre- Test Average</b>	<b>Post- Test Average</b>	<b>Success Rate</b>	<b>W</b>	<b>S</b>
ISCI	1101	<b>20031</b>	21	10	27%	49%	<b>74%</b>	2	2
ISCI online, WA	1101	<b>20072</b>	12	14	48%	80%	<b>58%</b>	4	3
PHYS	2212	<b>80408</b>	8	10	29%	40%	<b>80%</b>	0	2

I do not think that pre-and post-test are a good measure of how much students have learned and whether they have become good critical thinkers. I use other assessments during the semester (listed above) that give me a better idea if my students’ progress. But overall, the success rates that are shown here are satisfactory. I am still working on different ways to engage students in online classes and promote critical thinking in online environment where students have to be motivated learners. I am planning to introduce a research project in my online Integrated Science class in the fall of 2015.

**How will being a faculty champion for critical thinking impact your approach to teaching?**

I have always placed a great importance on critical thinking. I truly do not believe that teaching a science or math course is possible without engaging students in critical thinking. However, when I just started teaching, it seemed like the common approach was based on delivering power point lectures and administering multiple choice tests. I have quickly found out that this approach does not allow students to develop their full potential. Therefore, I started adding critical thinking components. I did it mainly to benefit my students. I have rarely documented particular activities and strategies that engaged my students in critical thinking. After becoming a faculty champion for critical thinking, I



have reconsidered my strategies and placed a lot more emphasis on documenting and sharing my findings to benefit my students, other faculty, and myself.

**If you worked with a faculty mentor, who did you work with and how did the mentor assist you?**

I did not work with the faculty mentor but I have picked up many useful strategies through communication with the faculty at Math and Science, other departments, and other colleges. I have also participated in our QEP meetings and have learned a lot about adding critical thinking components into humanities and social science courses.